

## CLAIMS

What is claimed is:

- 1           1. A tunable laser, comprising:
  - 2           a gain medium having an active emission layer to generate optical energy, the
  - 3           active emission layer having a first and a second facet;
  - 4           a first waveguide extending from the first facet, the first waveguide including a
  - 5           first core, the first core having a first end adjacent to the first facet for receiving optical
  - 6           energy, the first core fabricated from inorganic material and the first waveguide including
  - 7           inorganic material and thermo-optical organic material surrounding the first core;
  - 8           a second waveguide extending from the second facet, the second waveguide
  - 9           including a second core, the second core having a first end adjacent to the second facet
  - 10          for receiving optical energy, the second core fabricated from inorganic material and the
  - 11          second waveguide including inorganic material and thermo-optical organic material
  - 12          surrounding the second core;
  - 13          a substrate supporting the first waveguide, the second waveguide, and the gain
  - 14          means;
  - 15          a first reflector positioned to reflect optical energy propagating along the first
  - 16          waveguide if the optical energy has a wavelength that is one of a plurality of first
  - 17          reflection wavelengths;

18 a second reflector positioned to reflect optical energy propagating along the  
19 second waveguide if the optical energy has a wavelength that is one of plurality of second  
20 reflection wavelengths;  
21 a thermo-optical organic material positioned to shift the plurality of first and  
22 second reflection wavelengths in response to changes of temperature in the thermo-  
23 optical organic material; and  
24 a first thermal actuator thermally coupled to change the temperature in the thermo-  
25 optical organic material.

1 2. The tunable laser of claim 1 wherein the first waveguide includes a reflector-  
2 free portion interposed between the first end of the first core and the first reflector, the  
3 reflector-free portion including a phase control section.

1 3. The tunable laser of claim 2 further comprising thermo-optical organic material  
2 positioned in proximity to the phase control section.

1 4. The tunable laser of claim 3 wherein the thermo-optical organic material has a  
2 coefficient of refractive index variation as a function of temperature, the magnitude of  
3 which exceeds  $1 \times 10^{-4}/^{\circ}\text{C}$ .

1 5. The tunable laser of claim 3 wherein the thermo-optical organic material is  
2 selected from the group comprising a polymer derived from methacrylate, a polymer

3 derived from siloxane, a polymer derived from carbonate, a polymer derived from  
4 styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

1 6. The tunable laser of claim 1 wherein the first thermal actuator is selected from  
2 the group comprising a resistive heater, a thermoelectric heater, and a thermoelectric  
3 cooler.

1 7. The tunable laser of claim 3 wherein the first thermal actuator is coupled to  
2 change the temperature in the thermo-optical organic material adjacent to the phase  
3 control section, and further comprising:  
4 a second thermal actuator is coupled to change the temperature in the thermo-  
5 optical organic material adjacent to the first reflector; and  
6 a third thermal actuator is coupled to change the temperature in the thermo-optical  
7 organic material adjacent to the second reflector.

1 8. A tunable hybrid laser, comprising:  
2 a substrate fabricated of a first material;  
3 a gain medium fabricated of a second material and mounted onto the substrate, the  
4 gain medium including an active emission layer to generate optical energy, the active  
5 emission layer having a first and a second facet;  
6 a first waveguide disposed on the substrate and extending from the first facet, the  
7 first waveguide including a first core, the first core having a first end adjacent to the first

8 facet for receiving optical energy, the first core fabricated from inorganic material and the  
9 first waveguide including inorganic material and thermo-optical organic material  
10 surrounding the first core;

11 a first reflector positioned to reflect optical energy propagating along the first  
12 waveguide if the optical energy has a wavelength that is one of a plurality of first  
13 reflection wavelengths;

14 a second waveguide disposed on the substrate and extending from the second  
15 facet, the second waveguide including a second core, the second core having a first end  
16 adjacent to the second facet for receiving optical energy, the second core fabricated from  
17 inorganic material and the second waveguide including inorganic material and thermo-  
18 optical organic material surrounding the second core;

19 a second reflector positioned to reflect optical energy propagating along the  
20 second waveguide if the optical energy has a wavelength that is one of a plurality of  
21 second reflection wavelengths;

22 a thermo-optical organic material positioned to shift the plurality of first and  
23 second reflection wavelengths in response to changes of temperature in the thermo-  
24 optical organic material; and

25 a first thermal actuator thermally coupled to change the temperature in the thermo-  
26 optical organic material.

1           9. The tunable hybrid laser of claim 8 wherein the first waveguide includes a  
2 reflector-free portion interposed between the first end of the first core and the first  
3 reflector, the reflector-free portion including a phase control section.

1           10. The tunable hybrid laser of claim 9 further comprising thermo-optical organic  
2 material positioned in proximity to the phase control sections.

1           11. The tunable hybrid laser of claim 8 wherein the first thermal actuator is  
2 selected from the group comprising a resistive heater, a thermoelectric heater, and a  
3 thermoelectric cooler.

1           12. The tunable hybrid laser of claim 9 wherein the first thermal actuator is  
2 coupled to change the temperature in the thermo-optical organic material adjacent to the  
3 phase control section, and further comprising:  
4           a second thermal actuator is coupled to change the temperature in the thermo-  
5 optical organic material adjacent to the first reflector; and  
6           a third thermal actuator is coupled to change the temperature in the thermo-optical  
7 organic material adjacent to the second reflector.

1           13. The tunable hybrid laser of claim 8 wherein the first material is selected from  
2 the group comprising sapphire, gallium arsenide, indium phosphide, silicon, glass,  
3 ceramic, and metal.

1           14. The tunable hybrid laser of claim 8 wherein the second material is selected  
2           from the group comprising sapphire, gallium arsenide, and indium phosphide.

1           15. A tunable laser, comprising:  
2           a gain medium including an active emission layer to generate optical energy, the  
3           active emission layer having a facet;  
4           a waveguide extending from the facet, the waveguide including a core, the core  
5           having an end adjacent to the facet for receiving optical energy, the core fabricated from  
6           inorganic material and the waveguide including inorganic material and thermo-optical  
7           organic material surrounding the core;  
8           a substrate supporting the gain medium and the waveguide;  
9           a reflector positioned to reflect optical energy propagating along the waveguide if  
10          the optical energy has a wavelength that is one of a plurality of reflection wavelengths;  
11          thermo-optical organic material positioned to shift the plurality of reflection  
12          wavelengths in response to changes of temperature in the thermo-optical organic material;  
13          and  
14          a first thermal actuator thermally coupled to change the temperature in the thermo-  
15          optical organic material.

1           16. The tunable laser of claim 15 wherein the waveguide includes a reflector-free  
2           portion interposed between the end and the reflector, the reflector-free portion including a  
3           phase control section.

1           17. The tunable laser of claim 16 further comprising thermo-optical organic  
2           material positioned in proximity to the phase control section.

1           18. The tunable laser of claim 17 wherein the thermo-optical organic material has  
2           a coefficient of refractive index variation as a function of temperature, the magnitude of  
3           which exceeds  $1 \times 10^{-4}/^{\circ}\text{C}$ .

1           19. The tunable laser of claim 17 wherein the thermo-optical organic material is  
2           selected from the group comprising a polymer derived from methacrylate, a polymer  
3           derived from a siloxane, a polymer derived from carbonate, a polymer derived from  
4           styrene, a polymer derived from cyclic olefin, and a polymer derived from norbornene.

1           20. The tunable laser of claim 15 wherein the first thermal actuator is selected  
2           from the group comprising a resistive heater, a thermoelectric heater, and a thermoelectric  
3           cooler.

1           21. The tunable laser of claim 16 wherein the first thermal actuator is coupled to  
2 change the temperature in the thermo-optical organic material adjacent to the phase  
3 control section, and further comprising:  
4           a second thermal actuator is coupled to change the temperature in the thermo-  
5 optical organic material adjacent to the first reflector; and  
6           a third thermal actuator is coupled to change the temperature in the thermo-optical  
7 organic material adjacent to the second reflector.

1           22. The tunable laser of claim 15 wherein the core further comprise a taper  
2 adjacent to the first end for receiving optical energy.

1           23. An integrated optical component, comprising:  
2           a waveguide disposed on a substrate and including a core having an end for  
3 receiving optical energy, the core fabricated from inorganic material and the waveguide  
4 including an inorganic material and thermo-optical organic material surrounding the core;  
5           a first reflector positioned to reflect optical energy propagating along the  
6 waveguide if the optical energy has a wavelength that is one of a plurality of first  
7 reflection wavelengths;  
8           a second reflector positioned to reflect optical energy propagating along the  
9 waveguide if the optical energy has a wavelength that is one of plurality of second  
10 reflection wavelengths;



11 thermo-optical organic material positioned to shift the plurality of first and second  
12 reflection wavelengths in response to changes of temperature in the thermo-optical  
13 organic material; and  
14 a thermal actuator coupled to change the temperature in the thermo-optical  
15 organic material.

1 24. The integrated optical component of claim 23 wherein the waveguide  
2 includes a reflector-free portion interposed between the end and the first reflector and  
3 between the first reflector and the second reflector, the reflector-free portions including a  
4 phase control section.

1 25. The integrated optical component of claim 24 further comprising thermo-  
2 optical organic material positioned in proximity to the phase control sections.